Northern Gulf of California: Mexico

Dr. Diego Lercari [1,2]
[1]Unidad de Ciencias del Mar, Facultad de Ciencias, Universidad de la República
Iguá 4225 Esq. Mataojo C.P. 11400 Montevideo, Uruguay
[2]Centro Interdisciplinario de Ciências Marinas del IPN
Apartado Postal 592, La Paz, 23000, Baja Califórnia Sur, México
e–mail: lercari@gmail.com

Problem or questions to respond with Ecospace model

Are the MPAs in the NGC effective to enhance the vaquita and totoaba populations?
Which MPAs designs could optimize the vaquita and totoaba conservation?
How the potential enhancement could impacts in the catch and value obtained by the different fleets?

Description of Ecopath model

The mass-balanced model of the UGC ecosystem considers 37 functional groups: 4 for marine mammals; 2 birds; 18 fishes; 9 invertebrates; 1 zooplankton; 1 phytoplankton; 1 macroalgae; 1 detritus. These groups represent most abundant species in the NCG as well as peculiar groups composed only by one important species. This approach let us focus on modelling groups with economic, social or ecological values: *Totoaba macdonaldi; Phocoena sinus*, *Zalophus californianus* and the shrimps (*Farfantepenaeus californiensis* and *Lytopenaeus stylirostris*). In addition, juvenile stages were added as distinct functional groups in *Totoaba macdonaldi, Farfantepenaeus californiensis* and *Lytopenaeus stylirostris* to consider trophic ontogenic changes in this valuable species.

Number of fleets/gears

Eight fleets were included in the model (Table 1) considering the catch and the bycatch of 3 different gears in three different harbours: the industrial trawl, the small-scale shrimp fishery and the small-scale finfish gillnet gear.

Table 1. Fleets and gears operating in the NGC included in the ECOSPACE model.

Model Fleet #	Gear	Harbor
1	Shrimp trawl	Puerto Peñasco
2	Shrimp artisanal	Puerto Peñasco
3	Gillnets artisanal	Puerto Peñasco
4	Shrimp trawl	San Felipe
5	Shrimp artisanal	San Felipe
6	Gillnets artisanal	San Felipe
7	Shrimp artisanal	Santa Clara
8	Gillnets artisanal	Santa Clara

Habitats and MPAs defined in the ECOSPACE model

Seven different habitats (Table 2; Figure 1) were included in the ECOSPACE basemap, considering depth, bottom type and other special habitats.

Table 2. Definition of habitat for the NGC ECOSPACE model.

Habitat #	Habitat name	% of total area	Habitat description
1	> 200 m	19.3	Deepest areas
2	< 100 m	21.5	Shallower areas
3	100-200m	40.4	Intermediate depth area
4	Colorado River Delta	1.0	Highly productive area, nursery ground
5	Rocky bottom	4.5	
6	Bays and marsh	5.8	Highly productive area, nursery ground
7	Vaquita area	7.6	*Phocoena sinus* distribution area

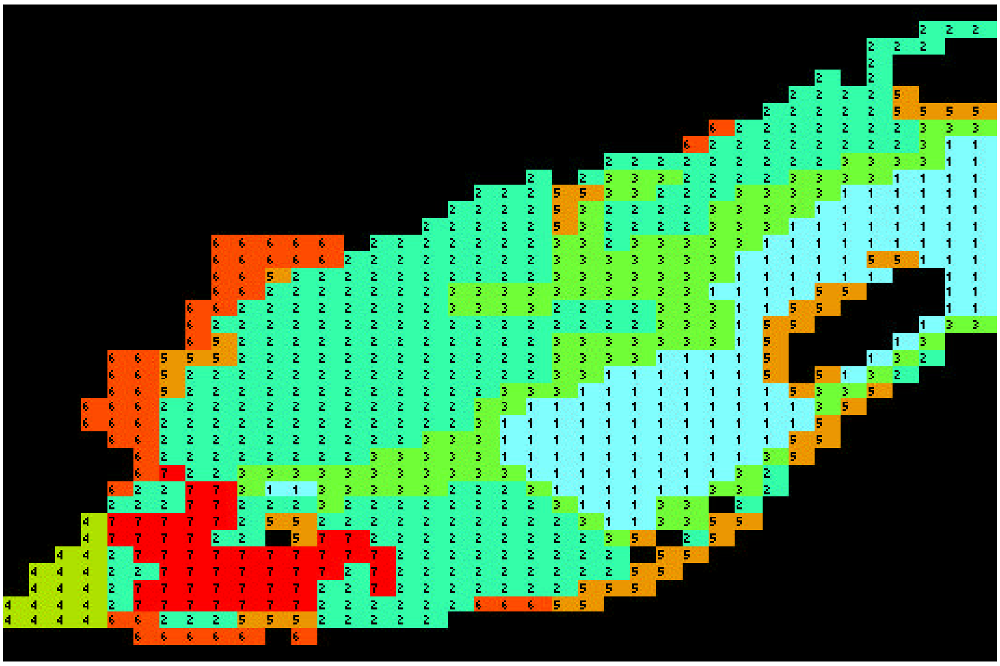

Figure 1. ECOSPACE basemap of the NGC showing the 7 habitat defined.

Problems why represent MPAs in the NGC ECOSPACE model.

There are three MPAs in the NGC, covering different objectives. There are no scientific analyses addressing the effects or effectiveness of these spatial management areas on neither the endangered species nor the commercial resources. Simulating changes on these areas we want to answer questions about the effectiveness of the MPAs in relation with the objectives planed dring its implementation.

MPA #	MPA name	MPA description
1	Core zone Biosphere Reserve	Corresponds to the Colorado River Delta. Fishing activities mostly banned. Only artisanal fleets form Santa Clara allowed to fish.
2	Bufer zone Biosphere Reserve	No shrimp trawling allowed
3	Vaquita refugee	All fishing totally banned inside a
4	Bays and shallowest areas	No shrimp trawling allowed

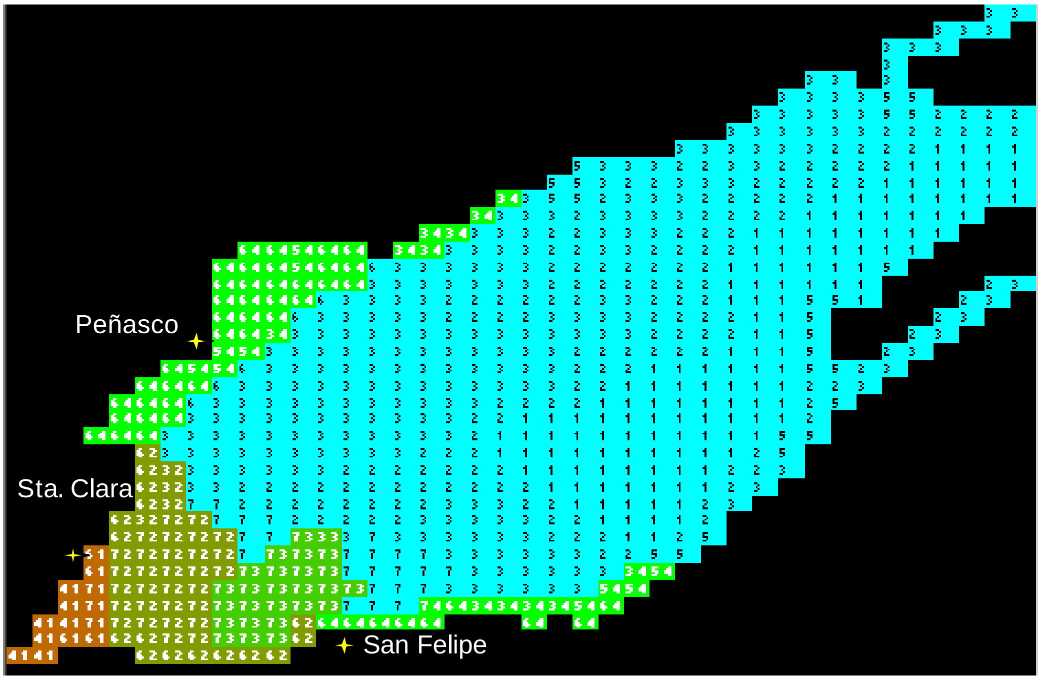

Figure 2. ECOSPACE location map of the MPAs in the NGC and main landing ports.

Fishing allocation

Spatial distributions of fishing were assigned using the actual regulations of the fisheries as well as a published map of fishing areas in the NGC. Fishing activities were restricted to those regions assigning high fishing cost in ECOSPACE. The fleet allocation maps obtained are showed in Figure 3.

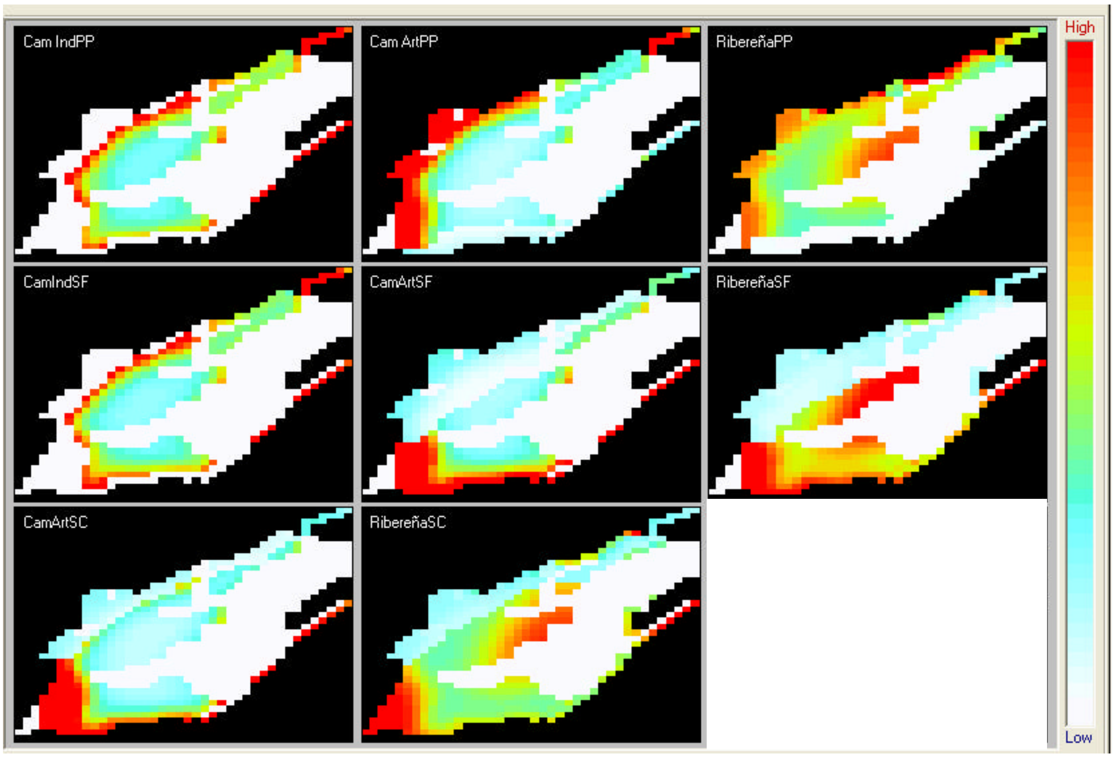

Figure 3. Spatial distribution of fishing effort obtained using ECOSPACE.

Advection fields and migration patterns

To adequately simulate known spatial distribution patterns in the NGC, it was included an advection field which follows the general circulation patterns in the NGC and affects the spatial distribution of the lowers trophic levels (i.e phytoplankton and detritus). Moreover, in some functional groups it was considered roughs migration patterns delineated from publicati ons.

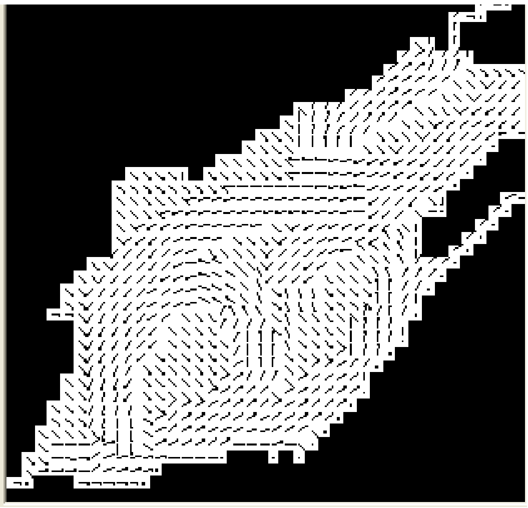

Figure 4. Advection field obtained using ECOSPACE, representing the general circulation patterns for the NGC.

Output maps and interpretations

Figure 5 shows the biomass distribution maps generated by ECOSPACE considering the actual fishing situation in the NGC. The distribution patterns obtained agree in general terms with previously reported distributions of every group considered.

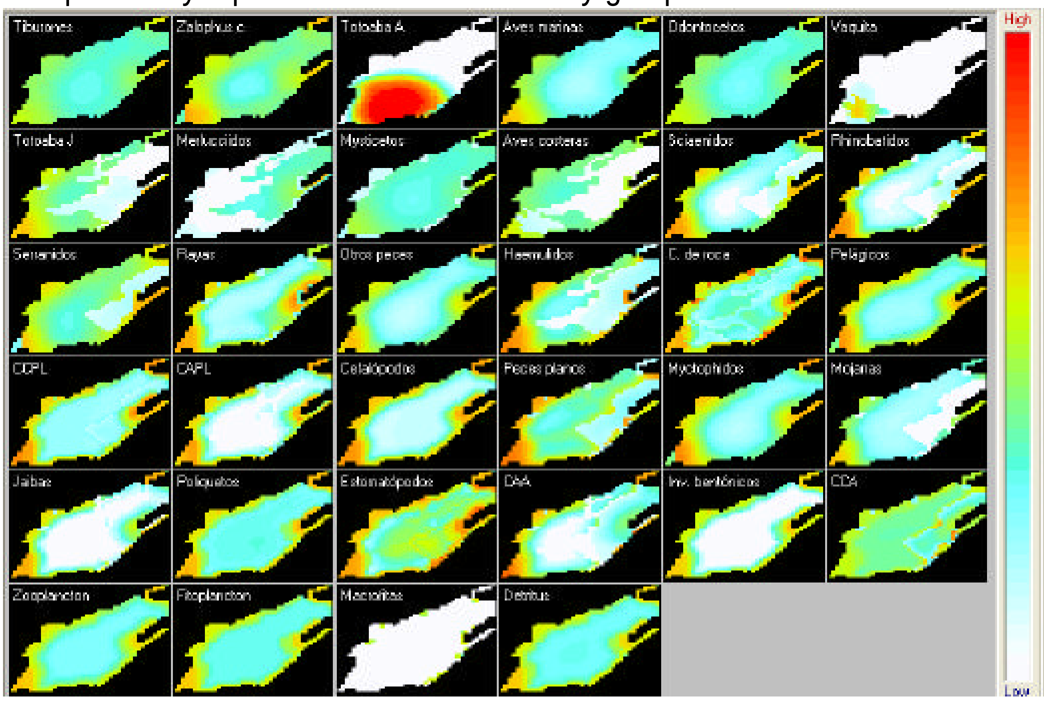

Figure 5. Simulated distributions patterns of every group modeled for the NGC after ECOSPACE.

The first problems detected consist in the decreasing trend during the simulation of the vaquita biomass. This could be due to the differential habitat assignment between predators and preys. The situation was improved correcting the habitat assignment of the small pelagics and mictophyds, main group predated by the vaquita. However, in general, the biomass trajectories were improved by initializating the ECOSPACE runs using the ECOPATH base biomass rather the habitat adjusted biomass ECOSPACE default setting.

Despite these initial troubles, we perform some basic simulations in order to explore the effectiveness of the MPAs in protecting the vaqita and totoaba populations. We test 4 scenarios:

Actual MPAs design
No fishing inside the vaquita refugee
No fishing inside the buffer zone
No fishing inside the vaquita distribution area

The results shown an undetectable variation in the spatial distribution patterns, however it was possible to detect an increase in the total biomass of these species as the protected are were increased (Figure 7).

<u>List of those aspects that could help in the improvement of the model</u>

a) Spatial allocation of environmental variables could help in the representation of external forcing factors occurring differentially over the modeled area (e.g. river runoff, temperature, etc.)

b) Multi layers could help to represent changing habitat (e.g. water mass defined habitats) and to reflect partially overlapped MPAs (e.g. vaqita refugee and buffer zone of the biosphere reserve).

c) A formal validation – fitting procedure could improve the match between independently obtained biomass maps (e.g. stock assessment) and ECOSPACE predictions in the distribution of the species.

d) ECOSPACE capabilities to directly read satellite images from different sensors and also to read GIS files formats.

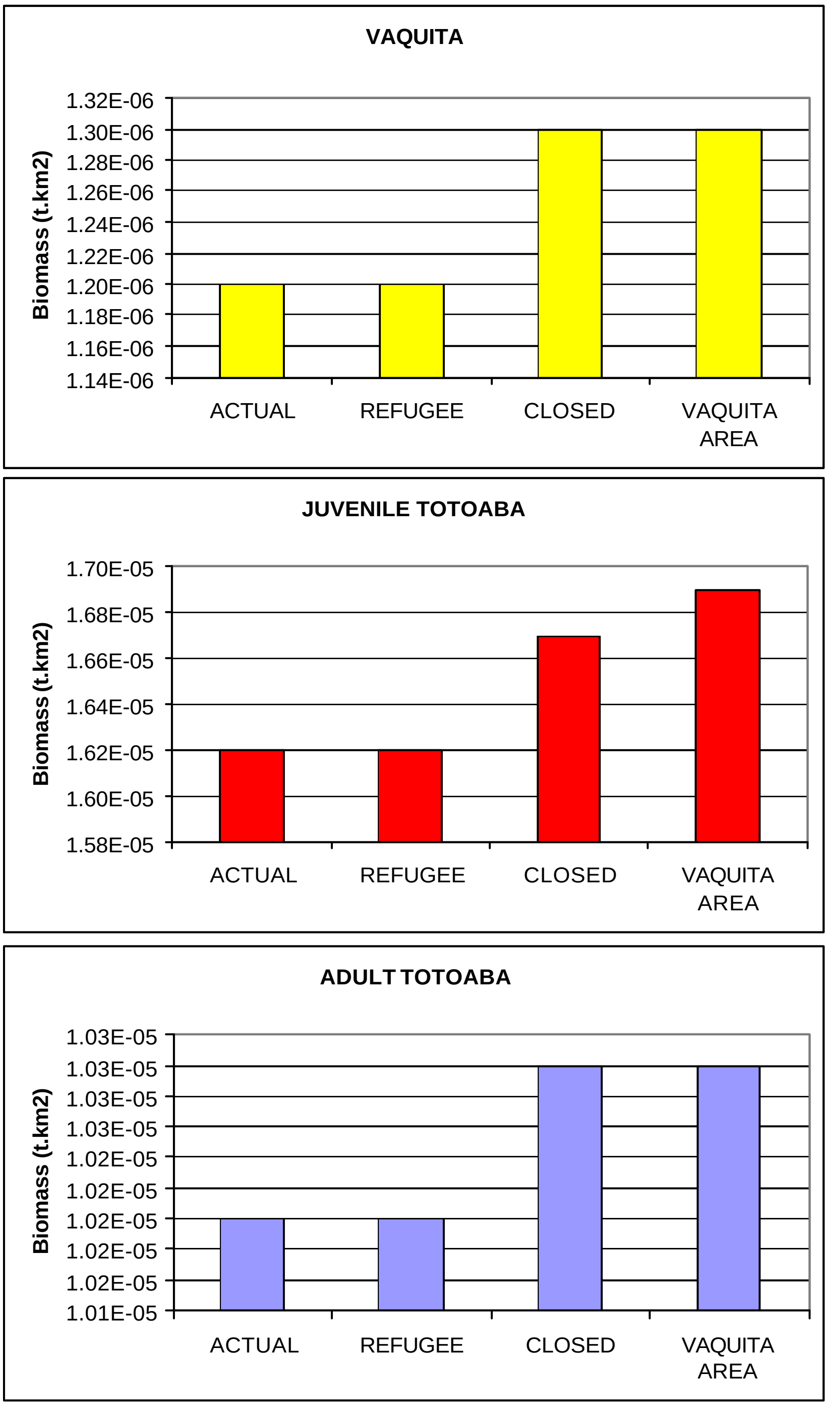

Figure 7. Final biomass after ECOSPACE obtained for the simulation of 4 scenarios, increasing the protected area.